ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY

International Comparative Analysis of Appliance Efficiency Standards & Labeling Programs: Implications for China

Nan Zhou, Nina Zheng, David Fridley and John Romankiewicz
China Energy Group
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory

Preprint version of paper for conference proceedings, ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, California, August 12-17, 2012.

June 2012

This work was supported by the China Sustainable Energy Program of the Energy Foundation and Collaborative Labeling and Appliance Standards Program through the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

International Comparative Analysis of Appliance Efficiency Standards & Labeling Programs: Implications for China

Nan Zhou, Nina Zheng, David Fridley and John Romankiewicz
China Energy Group
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory

ABSTRACT

As a growing consumer of household appliances, lighting and electronic products, China has seen a steady rise in residential electricity use with 13% average annual growth since the 1980s. Over the last twenty years, China has implemented a series of new minimum energy performance standards (MEPS) and mandatory and voluntary energy labels to improve appliance energy efficiency. As China begins planning for the next phase of standards and labeling (S&L) program development under the 12th Five Year Plan, an evaluation of recent program developments and future directions is undertaken by drawing upon the experiences and lessons learned of key international S&L program development. Specifically, this study provides in-depth review and comparative analysis of the development and recent advancements in the U.S. MEPS and Energy Star, Australia MEPS and Energy Label, European Union MEPS and Eco-Design Label and Japanese Top Runner programs with China's S&L program. The international comparative analysis focuses on key elements of S&L development including stakeholder participation, program resources, data collection and availability, analytical methods, as well as program implementation and enforcement mechanisms. This study finds that adequate program resources from national and local levels, wide-ranging stakeholder participation, incorporation of various technical and economic analyses in standards development, and program impact evaluations are key features of successful S&L programs and have room for improvement in China. At the same time, however, China has become more proactive than some international programs in areas such as launching check-testing, laboratory round-robin testing and compliance verification for S&L programs.

Introduction

Appliance energy efficiency standards and labeling (S&L) programs have been important energy efficiency policy tools for regulating the efficiency of energy-using products for over 40 years and have continued to expand in terms of geographic and product coverage. As a mandatory policy, minimum energy performance standards (MEPS) help push the efficiency of products on the market by setting energy efficiency metrics that must be met and help eliminate inefficient products that cannot meet the standard. At the same time, mandatory and/or voluntary energy information and endorsement labels seek to pull the market for efficient products by providing information for consumers to identify and/or compare the energy efficiency of similar product models in their purchase decision-making.

While S&L programs have been in effect for over three decades in most developed countries and regions, they have only recently begun receiving policy attention in rapidly growing and developing countries. Table 1 reviews the legal framework for S&L programs and the current status of each region's MEPS and labeling programs. The U.S., Australia and Japan have all had energy performance standards or targets for appliances and household equipment since the late 1970s followed by the subsequent launch of energy information labeling programs in the 1990s. The European Union (EU) mandatory energy label was launched upon the creation of the EU and followed shortly by legislation for mandatory MEPS in 1996. Since their initiation, the MEPS and labeling programs in these four economically developed regions have continued to receive policy attention through supporting legislation, program funding and enhancement of implementation and enforcement mechanisms. China, in contrast, introduced MEPS for appliances in 1989 but efficiency standards did not gain traction in the policy arena until the late 1990s when it was formally endorsed by legislation. The voluntary energy labeling program was established in China in 1999 and the mandatory information labeling program came into existence in 2005 (Zhou 2008).

Table 1: Legal Framework and Current Status of Selected International S&L Programs

	Basis of Legal Framework	Current Status
U.S.	1975: Energy Policy & Conservation Act on standards development and EnergyGuide label	Over 40 MEPS
	1987: legislation set deadlines for specific standards	Nearly 50 ENERGY STAR products
Australia	1980s: three states unilaterally created mandatory energy label	17 MEPS
	1992: national committee (now Equipment Energy Efficiency or E3 Committee) created to coordinate S&L	7 mandatory energy labels
	1999: all jurisdictions implemented state and territory regulations for mandatory label and MEPS	2 voluntary labels
EU	1992: Directive 1992/75/EEC introduced mandatory comparative information label, label implementation and MEPS required by 1996 Directive	10 Ecodesign priority products identified for 2009-11
	2005: Directive 2005/32/EC introduced Ecodesign framework that also covers environmental aspects	
Japan	1979: Energy Conservation Law introduced S&L	24 Top Runner standards
	1998: Revised Energy Conservation Law introduced Top Runner standards	Labels for 16 Products
	2000: Voluntary endorsement label created, later integrated in comparative energy label in 2006	
China	1988: Standardization Law of China introduced MEPS program, first MEPS adopted in 1989	Over 40 MEPS
	1995: China National Institute of Standardization authorized to organize MEPS development and revision	Over 50 voluntary certification labels
	1997: regulatory basis for mandatory MEPS provided in Energy Conservation Law	23 mandatory energy labels
	1999: voluntary certification label introduced; 2005: mandatory comparative energy information label created	

Sources: DOE 2012, Ellis 2012, Waide 2011, METI 2010, Zhou 2008, Saheb et al. 2011.

In recent years, China has placed increasingly greater policy emphasis on appliance efficiency programs as residential electricity use has risen steadily with 13% average annual growth and promoting energy efficiency has become a national policy goal (NBS 2011). Despite program improvements such as broader product coverage and more frequent standard revisions, China lacks a formalized regulatory process for standard-setting and faces challenges in conducting rigorous, data-driven technical and economic analyses for standard setting. While China has emerged as a leader in a national verification testing scheme with complementary pilot check-testing projects, it still faces challenges with insufficient funding, low local awareness and resistance to check-testing by some manufacturers, limited product sampling scope, and testing inconsistency and incomparability of results. In light of these remaining challenges, China is developing plans for strengthening and improving its appliance S&L program for the 12th Five Year Plan period (2011-2015). An analysis of the gaps between China's current programs and international best practices can therefore help identify these gaps and provide concrete recommendations to facilitate planning and implementation of reforms and new directions.

This paper uses two extensive reports to be published by the Lawrence Berkeley National Laboratory in late 2012 - one focused on the program development and implementation of recognized S&L leaders including the U.S., Australia, Japan and the EU and another specifically on China's S&L program development and challenges - to draw upon international experiences as the basis for China's further program development (Zhou et al. 2012a, 2012b). This paper first provides comparative analysis of major components of the standard setting and revision process, including: standard-setting principles and timelines, data collection and availability, analytical methods and tools, test procedures and stakeholder participation.[1]Combined with further comparison and analysis of program resources and enforcement mechanisms, best practice examples of each programmatic element as well as cross-cutting factors for success and lessons learned in S&L development and implementation are identified and discussed in the context of China's S&L program. [2]

Comparative Analysis of Standard Setting Processes

Standard Setting Timeline and Principles

The legal framework of the four different S&L programs reveal that most programs have a specified timeline for setting new or revised efficiency standards laid out in legislations and regulations, which help ensure that standards will not become irrelevant and obsolete and reduce risks for manufacturers. In some cases such as the U.S., the legally binding schedule for setting efficiency standards provides non-governmental organizations with a legal channel to challenge delays in standard-setting. In Japan, because the Top Runner standards are not MEPS, they do not follow a specified schedule since the

[1] The specific details of each S&L program are not presented in this paper due to space constraints. In some cases, a summary table of key information for each program may be presented here. However, comprehensive details of each program can be found in one of the reports on which this paper is based: Zhou et al. 2012a.

[2] Due to space constraints and coverage in many other reports and papers, detailed background information on China's S&L programs are not included in this paper. References for further understanding China's S&L program development and implementation can be found in Saheb et al. 2011, Zhou 2008 and Zhou et al. 2012b.

duration of each Top Runner target or standard is dependent on market development and technological progress.

The guiding principles and specific steps and analyses undertaken as part of the energy efficiency standard setting and revision process are crucial in influencing the subsequent impacts of the standards on energy savings and emission reductions. There are key similarities in the standard setting criteria of standards programs in the four selected countries and regions, despite differences in each program's underlying regulatory framework and history. For all four programs, new or revised standards can only be set if the standards achieve significant energy savings through measures that are technologically feasible and economically justified. First, although the specific threshold for defining significant energy savings potential may differ between countries, the savings potential criterion is typically met if a given product has high sales volume and/or high per unit energy consumption. The EU Ecodesign directive for energy using products has a broader scope and includes additional factors to energy consumption, such as waste, air pollutants and water usage when determining environmental impact. Second, technological feasibility is incorporated into the standard-setting analyses in all four programs. In the U.S., Australia and the EU, technical analysis of best available or beyond technology options for setting MEPS levels serves as the basis for evaluating technological feasibility. In Japan, analysis of potential technological improvement trends is conducted in setting the Top Runner target value and year. This ensures, when shown to be economically feasible, that the future MEPS will be set at levels that exceed the average product on the market and will be effective in pushing towards higher efficiency levels once implemented. Third, key criterion for setting standard levels include ensuring that there are no excessive costs associated with a new or revised standard as determined through economic impact analysis, particularly on consumers and manufacturers. Interestingly, though, Australia's Ministerial Council on Energy agreed in 2006 for the first time to consider regulating products even under circumstances where cost is imposed upon the community provided that regulation will offset even more expensive mitigation actions in the future (Ellis 2012).

Data collection and availability

Basic data on end-use usage and energy consumption patterns can inform the standards development process by highlighting major energy users and the potential for energy savings. Similarly, sales data and data on the efficiency levels of products sold in the market can inform S&L revision by illustrating the technical potential for efficiency improvement.

Of the four selected countries and regions, the U.S.'s Residential Energy Consumption Survey (RECS), conducted by the U.S. Department of Energy's Energy Information Administration, provides the most robust data collection for informing the development and revisions of MEPS and ENERGY STAR requirements. This comprehensive household survey has been conducted every four years since 1978 by collecting data from 4000 households statistically selected to represent all U.S. households (EIA 2011). It provides publicly available information on the physical characteristics of housing units, appliances usage, demographic and household characteristics, types of fuels used, and energy consumption and expenditure data for major fuels. RECS as a data resource is also important in that it is publicly accessible and can inform concerned stakeholders such as efficiency advocates or consumer groups as to which products may need to be added to the MEPS or ENERGY STAR program based on end-use energy usage patterns. In Australia, the Bureau of Statistics began conducting household energy expenditure surveys in 2009.

In terms of sales data and efficiency trends of products on the market, all four regions take advantage of similar resources such as regional (e.g., EU member states or local Australian jurisdictions) or programmatic (e.g., ENERGY STAR, Top Runner, and Australia product registration) reporting requirements and purchased data from consulting companies and trade associations. U.S. and Australian sales and market data can be disclosed to the public, thereby making it possible for third-parties to cross-check and raise concerns about self-reported energy performance results. In contrast, only regulators can question compliance results in Japan because the Top Runner manufacturers' compliance data questionnaires are not disclosed to the public.

Analytical methods and tools

With accurate and representative data as key inputs, well-founded technical, economic, and cross-cutting analyses and tools serve as the basis for establishing MEPS and labeling thresholds. While all countries have some analytical basis for determining the regulated efficiency levels, the scope and depth of these analyses and tools vary. Table 2 presents an overview of the major analyses undertaken in the four selected regions.

Table 2: MEPS Standard-Setting Analyses by Region

	Analysis Overview	US MEPS	Australia MEPS	EU Ecodesign	Japan	China
Screening Analysis	screen potential product design options or efficiency levels	X	X	X	N/A	X
Engineering Analysis	evaluate and compare different design change or efficiency levels' effect on reducing energy use and cost	X	X	X	N/A	
Energy and Water Use Analysis	estimate operational energy and water for efficiency level	X	X	X	N/A	
Mark-up Analysis	convert consumer price to estimated manufacturer cost	X	X		N/A	
Life-cycle Cost and Payback Analysis	evaluate life-cycle economic impact of potential standard level on end-users	X	X	X	N/A	
Market Analysis	evaluate efficiencies of current models in market		X	X	X	X
Shipment Analysis	current and forecast shipment analysis	X		X	X	
National Impacts Analysis	evaluate potential energy and economic impact on national level	X	X	X	N/A	
Manufacturer Impact Analysis	evaluates the impact on manufacturers' competitiveness, industry structure	X	X	X	N/A	
Life-cycle Cost Subgroup Analysis	evaluate disparity of impacts on specific consumer groups	X	X	X	N/A	
Employment Impact Analysis	evaluate net jobs created or eliminated	X	X	X	N/A	
Utility Impact Analysis	evaluate impact on national electricity and gas suppliers	X	X		N/A	
Regulatory Impact Analysis	evaluate and compare impacts of non-regulatory alternatives	X	X	X	N/A	
Environmental Assessment	evaluate impact on CO_2, SO_2 and NOx emissions	X	Only CO_2	Life-cycle env't impact	N/A	Only CO_2

With the exception of Japan, the countries and regions examined follow a specific set of analytical methods and tools in the process of setting MEPS and Ecodesign implementing measures to ensure that regulatory criteria are met. Japan's standard-setting approach differs in that it relies largely on the progress of innovation amongst a few large manufacturers and regulators' outlook on future technological development (METI 2010). In the other three regions, analytical processes and the involvement of non-manufacturer stakeholders serve as the basis for justifying policy action and for affirming that standard-setting principles are met in choosing the most appropriate efficiency level for standards. For the U.S., the EU and Australia, consumer, manufacturer, national and regulatory impact analyses are all mandated in the standard setting process. In addition, the U.S., Australia and the EU also utilize third-party technical analysis to identify the best available technology options and life cycle cost analysis to evaluate the proposed regulatory level's impact on consumers. The EU stands out from the other three countries in that it adopts a life-cycle perspective of not only operational cost of the proposed Ecodesign implementing measure, but also of energy and environmental impact of the product.

Stakeholder Participation

In almost all S&L programs, stakeholders are invited to participate in the different stages of standards development to varying degrees to ensure that their viewpoints and concerns are addressed in the process and that the resulting appliance efficiency policy is not unreasonable. The key stakeholders in the standard development process often include government officials and regulators, manufacturers and industry representatives, consumer advocacy groups, environmental and efficiency advocacy groups, power utility groups and other researchers in academia, consulting, and think tanks. From the experiences of the four selected regions, the two key forms of stakeholder involvement and public participation are formal membership in committees and forums that inform the standard setting and regulatory decision-making processes and participation in stakeholder meetings or comment periods.

All four regions are required to offer at least one open comment period for stakeholder input to the formulation of standards. Japan, the EU and Australia offer comment periods after the release of an initial proposal or preparatory study for a standard. The U.S. stands out by holding open comment periods during various stages of the standard setting process, including accepting public comments during the product selection stage before any analysis is done, but is the only country that does not grant formal membership to stakeholders. The EU, Japan and Australia all ensure that key stakeholders are guaranteed a voice in the standard development and revision process via membership in regulatory committees responsible for setting and implementing the efficiency standards. Likewise, the EU, Japan and Australia involve all stakeholders in the standard development and revision process, while environmental and efficiency advocacy groups are not included in the Japanese stakeholder process. In China, stakeholder participation is further limited to only government, manufacturers and industry and select researchers with expert working group meetings that are not open to the public.

Program Implementation and Enforcement

Standard setting and development provide sound and scientific foundation to strong S&L programs, while implementation and enforcement are crucial to ensuring that the carefully developed S&L programs are effectively carried out. The energy savings and emission reduction impacts of S&L programs depend not only on how stringent a standard may be or how often a label is revised to reflect changing market conditions, but also on how many products actually meet the standard and how accurate the label information is. Two key components to implementing MEPS and mandatory energy labeling programs are the resources supporting the programs and the tools and mechanisms available to regulatory agencies to enforce compliance and deter violations.

Program Resources

Different levels of budgetary support and varying scope and responsibilities make it difficult to directly compare national or regional S&L programs, but some broad similarities and differences can be noted. Despite differing scopes, most of the programmatic budgets for the S&L programs were in the range of USD $5 million to USD $35 million.[3] Both Australia and the UK had budgets of around $5-$10 million USD for their programs, with the UK budget including the Market Transformation Program budget, annual enforcement costs and expected testing costs for the Ecodesign market surveillance framework (Wilkenfield & Associates and Marsden Associates 2010). However, it must be noted that a different number of standards are developed and implemented in each country so the total programmatic budgets may not be directly comparable.

Australia is unique in that its programmatic budget is divided between the Commonwealth of Australia and its state and territories, with states and territories contributing as much as 25% of the programmatic budget. In contrast, the European Commission does not provide any direct financial support for the EU MEPS, labeling or Ecodesign policies and instead, places all implementation responsibilities on the member states. Although the UK program is well developed and funded, the lack of EU-level funding means that implementation and enforcement of S&L programs will be highly dependent on the institutional support and financial capacity of individual member states. The U.S. program is funded and implemented entirely by the federal government, with some states playing minor roles in administering complementary or supplementary programs such as public awareness campaigns, ENERGY STAR program rebates and testing and compliance verification as in the case of California.

Table 3: Comparison of Regional Budgets for S&L Programs

	Approximate Budget	Funding Sources	Staff Resources
US	~ USD $35 million/year	National Budget via Federal Government	~ 100 employees total (including contractors)
Australia	~ AUD $10 million (USD $9.2 million)/year	75% from Commonwealth government, 25% from states and territories	~ 40 full-time equivalent staff
EU (UK example)	~ £3.3 million/year (USD $5.1 million)	National government via Market Transformation Program; cost-sharing being considered for enforcement program	Unknown
China	~55,000 – 105,000 USD/standard	Allocation from national budget for standards development and testing for all consumer products; international funding.	Unknown

Note: Approximate total budgets may not be directly comparable as the number of standards and labels being developed may differ between countries for a given year. (Cymbalsky 2012,Wilkenfield & Associates and Marsden Associates 2010, Saheb et al. 2011)

[3] Estimates in USD provided assuming 2010 annual average currency exchange rates from OANDA

Program Enforcement

There are typically two main types of enforcement mechanisms for S&L programs: product certification or registration by the manufacturer before retail distribution and product verification check-testing after retail distribution. Product certification usually requires manufacturers to test their products and submit certified results that the energy performance of the products meets MEPS and/or labeling requirements before the product can enter the market. Verification check-testing often involves purchasing samples from retailers or distributors to test for compliance in qualified laboratories, with manufacturers required to either immediately address and correct performance issues or pay fines and penalties for non-compliance and possibly cease product distribution if compliance cannot be met. All verification check-testing programs are conducted in one or two stages, with an optional second stage of re-testing offered to manufacturers whose products fail the first stage of testing. Informal enforcement mechanisms such as self-reporting of suspected non-compliance amongst manufacturers and negative publicity for non-compliant manufacturers may also be used to further deter non-compliance (METI 2010, DOE 2012).

Although implementation mechanisms such as certification and manufacturer reporting requirements were included in the regulatory framework for all four countries, the extent and form of enforcement and compliance verification mechanisms differ significantly among the four regions examined as seen in Table 4.

Table 4: Comparison of Major Elements of S&L Program Enforcement

	U.S.	Australia	EU/UK	Japan	China
Certification requirements	Previously one-time self-certification, now require annual reporting requirements	Mandatory self-reported registration program for products	Documentation requirements for MEPS and Label	Self reported sales and efficiency in annual questionnaires	Self-reported manufacturer certification for China Energy Label
Check-testing	Pilot program for selected ENERGY STAR-labeled products started in 2010; DOE began conducting enforcement and round-robin testing in 2011.	Longest and most extensive check-testing program	Varies on a country-by-country basis, dependent on laboratory testing capacities	None; only inspections of product catalogues and retail store surveys	May be included in national product quality testing. Pilot local check-tests.
Sample Selection Method	Testing for reported non-compliance: DOE inspector selects from samples provided by manufacturer. ENERGY STAR pilot testing samples purchased from	Test sample models selected base on risk of failure and likely impact on program outcomes (e.g., newer, high volume or high claimed efficiency models). Stage 1 unit purchased anonymously from	Stage 1 units purchased anonymously from retailer. Stage 2 units provided by manufacturer.	None	Random selection from manufacturers and/or retailers.

	retailers.	retailer or wholesale supplier. Stage 2 units randomly selected by regulators from samples provided by manufacturers.			
Compliance verification	Testing of energy efficiency compliance with MEPS only	Both energy efficiency compliance with MEPS and labeling accuracy and conformity verified	Energy efficiency compliance with MEPS and labeling accuracy and conformity verified but varies by country	None	National product quality testing primarily focuses on product safety and performance; pilot check-test focus on efficiency.
Fines/penalty for Non-compliance	USD $110/product/day	Product registration cancelled. On the spot fines and compensation for consumers have been negotiated in previous cases of non-compliance.	Criminal sanctions with maximum fine of £5000; proposal for civil sanctions	Up to ¥1,000,000	MEPS violations: fine 1 to 5 times illegal gains made from sales. Label violations: RMB 30,000 – 100,000.
Testing budget	Not known	AUD $0.5-AUD $1.5 million dollars	Varies by country, UK has specific budget of around £0.6 to £1.9 million.	Not known	500,000 RMB for national quality testing (not only energy); 200,000 RMB for pilot tests.
Informal enforcement mechanisms	Self-policing amongst manufacturers through complaints hotline	Public reporting of all compliance and enforcement activities and results, including the identification of suppliers of non-compliant products	None	Name and shame approach of publicizing non-compliance	None
Information sharing between agencies or jurisdictions	Limited; Collaborated on ENERGY STAR testing framework but no formal information sharing .	Between local jurisdictions and the Commonwealth	Ecodesign directive requires immediate information exchange between member states	None	None
Voluntary certification programs	AHAM; AHRI certification programs open to all manufacturers	None	Eurovent; national promotional campaigns in UK and Denmark	None	Voluntary energy efficiency certification program.

Source: DOE 2012, Ellis 2012, Wilkenfeld & Associates 2010, METI 2010, Saheb et al. 2011.

All five regions have certification or registration requirements, with the U.S. and EU outlining specific reporting requirements in their S&L regulations. Australia differs in that its product registration program is approved and managed by local jurisdictions, although the online registration system has increased the centralization of certification and registration in the absence of a national program. Japan does not have specific certification requirements, and requires only annual reports of sales and efficiency by model units from manufacturers. Compared to the U.S. and Japan, the EU and Australia both have relatively established and extensive check-testing programs for enforcing compliance with both energy performance and labeling requirements, although specific enforcement efforts vary by jurisdiction (i.e., Australian states and territories and EU member states). Australia and the UK are also the only countries that have a specific testing budget within their S&L programs and financial penalties for non-compliance (Waide 2011; Ellis 2012).

Prior to 2010, the U.S. DOE conducted verification testing only if it received a third-party written complaint against a manufacturer's product, such as from competing manufacturers or consumer groups. Over the last two years, the U.S. DOE has also launched targeted testing, a new public certification database, pilot round-robin testing to verify laboratory testing capabilities and is currently pursuing over one hundred compliance verification cases (Cymbalsky 2012). However, the U.S. program differs in that it only tests for energy performance and does not include inspections on labeling compliance with the EnergyGuide or ENERGY STAR label. Japan does not have any formal check-testing or compliance testing programs and relies mostly on periodic reviews of product catalogues and retail store surveys for verification. Since neither the U.S. nor Japan has established testing programs, they have relied heavily on informal enforcement mechanisms. The U.S. also has legal provisions for fines of up to USD$110 per product per day of non-compliance. Similarly, the key approach to rectifying non-compliance in Japan is informally naming and shaming the manufacturer in public, although fines of up to ¥1,000,000 are possible (METI 2010).

Key Findings: Implications for China's S&L Program

The comparative review of S&L programs in the U.S., Australia, EU and Japan have uncovered some overarching themes and highlighted several key factors to successful program elements:

Sound Legal Framework for Standard-Setting

Standard-setting and programmatic implementation can benefit significantly from a legal framework that directly specifies a timeline or schedule for standard-setting and revision, product coverage and legal sanctions for non-compliance. This is particularly true for China, which currently lacks a formalized regulatory process for standard-setting and does not have any legal or regulatory guidance on elements of S&L development such as stakeholder participation or the issue of legal precedence between conflicting national, industrial and local standards. China's laws regarding standard-setting and management of the mandatory energy labeling programs could also be updated, as they have not been amended or revised recently and no longer reflect the current situation.

Standard-setting Principle Focused on Maximizing Feasible Energy Savings

Programs in the four regions revealed similarities in guiding principles of standards development that focus on achieving significant energy savings that are technically feasible and economically justified. China uses similar metrics for choosing target products, including energy consumption, mature industry and testing procedures and stakeholder support. However, recent MEPS revisions have generally aimed at only eliminating the bottom 20% in efficiency of the market. Setting a firm principle based on maximizing energy savings that are technically feasible and economically justified may help improve the stringency of China's MEPS program and reduce the need for frequent revisions.

Data and Analytical Support for Comprehensive Standard-Setting Analysis

In terms of analytical support for standard-setting, detailed survey data such as the U.S. Residential Energy Consumption Survey and rigorous sets of technical, economic, energy and environmental analyses provide a strong foundation for setting and justifying a particular standard level. China currently lacks robust survey data and relies primarily on market research or data input in the mandatory label registration and certification process. Due to this lack of data as well as inadequate financial support and technological capabilities, China currently uses relatively simple techno-economic analyses in determining its efficiency standards levels rather than the specific sets of analyses and tools used internationally. Inclusion of more detailed energy consumption surveys in the Chinese national census surveys and statistical reporting systems could help provide the necessary data for more comprehensive standard-setting analyses.

Stakeholder Involvement in Standards Development and Implementation Process

Stakeholder participation can also strengthen the standard-setting process by incorporating insights from different groups of stakeholders, although the particular form of participation may vary between countries. Compared to the four selected regions, stakeholder participation in China is currently very limited and offering public participation mechanisms can better reflect the interests of broader groups of Chinese stakeholders.

Effective Enforcement and Program Resources

Sufficient program resources are critical to the effectiveness of S&L programs and cost-sharing between national and local governments can be undertaken to ensure adequate resources and uniform implementation. Resources are needed to support enforcement mechanisms such as check-testing and monitoring, which in turn impact the effectiveness of punitive measures such as cancellation of registration or product sales-based fines as effective deterrents for non-compliance. While China has established national verification testing scheme with complementary pilot check-testing projects, it still faces challenges in enforcement. On the national level, the main regulatory agency responsible for verification testing has limited resources and too many conflicting priorities, resulting in little emphasis on energy efficiency. The smaller scale pilot check-testing projects is under-funded, lacks local awareness, faces some manufacturer resistance to check-testing and is limited in testing capabilities and scope. Thus, further financial and staff resources and capacity building will be needed to overcome these remaining challenges and to expand impacts evaluations to assess the actual effectiveness of implementation and enforcement.

Conclusions

The international review of the four selected regions illustrates that while no single country has best practices in all elements of S&L development and implementation, national examples of best practices for individual elements do exist. For example, the U.S. has demonstrated rigorous analyses for standard-setting and a robust data source with the RECS database, while Japan's Top Runner standard-setting principle has been effective in motivating manufacturers to exceed targets ahead of time. In terms of standards implementation and enforcement, Australia has demonstrated success in enforcement with its long history of check-testing and enforcement initiatives while mandatory information-sharing between EU jurisdictions on compliance results is another important enforcement mechanism. As reflected by these examples, it is important to understand not only the drivers of different paths of S&L development, but also the country-specific context for examples of best practices in understanding why certain S&L programs have been effective. Recognizing and understanding drivers of effective international S&L program development and implementation can help inform China and other rapidly growing countries in their own paths of developing and implementing effective S&L programs.

Acknowledgments

This work was supported by the China Sustainable Energy Program of the Energy Foundation and the Collaborative Labeling and Appliance Standards Program through the U.S. Department of Energy.

References

Cymbalsky, John (Department of Energy). 2012. Personal Communication. 13 March 2012.

Ellis, Mark (Mark Ellis & Associates). Personal Communication. 13 February 2012.

Ministry of Economy, Trade and Industry (METI). 2010. "Top Runner Program: Developing the World's Best Energy-Efficient Appliances (Revised edition March 2010)." Available at: http://www.enecho.meti.go.jp/policy/saveenergy/toprunner2010.03en.pdf

National Bureau of Statistics of China (NBS). 2011. "China Energy Statistical Yearbook 2010." Beijing: China Statistics Press.

Saheb, Y., Zhou, N., Fridley, D., and A. Pierrot. 2011. *Compliance and Verification of Standards and Labeling Programs in China.* LBNL Report-4599E. Berkeley, California: Lawrence Berkeley National Laboratory.

U.S. Department of Energy (DOE). 2012. "Appliances & Commercial Equipment." http://www1.eere.energy.gov/buildings/appliance_standards/index.html

U.S. Energy Information Administration (EIA). 2011. "Residential Energy Consumption Survey (RECS)." http://205.254.135.7/consumption/residential/

Waide, P. 2011. "Overview and Update of the ERP Directive, Energy Labelling Directive and Eco-label in the European Union." Presented at the Asian Energy Efficiency Standards and Labeling Forum. Guilin, China: 15 November 2011.

Wilkenfeld G. and Associates and Jacob M. Associates. 2010. "Consultation Regulation Impact Statement: National Legislation for Appliance and Equipment Minimum Energy Performance Standards (MEPS) and Energy Labeling." http://www.energyrating.gov.au/library/pubs/201001-consultation-ris-national-MEPS-labelling.pdf

Zhou N. 2008. Status of China's Energy Efficiency Standards and Labels for Appliances and International Collaboration. LBNL Report-251E. Berkeley, California: Lawrence Berkeley National Laboratory.

Zhou N., N. Zheng & D. Fridley. 2012a. International Review of the Development and Implementation of Energy Efficiency Standards and Labeling Programs. LBNL Report, forthcoming. Berkeley, California: Lawrence Berkeley National Laboratory.

Zhou N., N. Zheng & D. Fridley. 2012b. Development and Implementation of Energy Efficiency Standards and Labeling Programs in China: Progress and Challenges. LBNL Report, forthcoming. Berkeley, California: Lawrence Berkeley National Laboratory.